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(54) **CONTROLLED PULSE AIR FILTER SYSTEM**

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See application file for complete search history.

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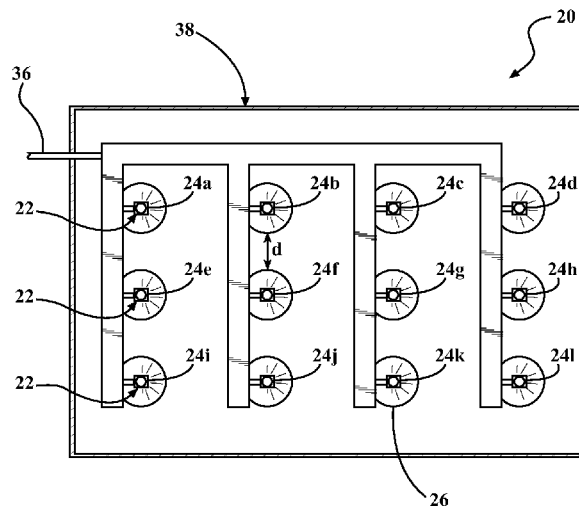
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CPC **B01D 46/0068** (2013.01); **B01D 46/2403**
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USPC 55/282–305, 341.1–341.7, 361–382;

(57) **ABSTRACT**

An air filtering system and method for self-cleaning the same is provided. The system has a plurality of air filters including a first filter and at least one neighboring filter. A blower fan pulls air through the filters. A plurality of compressed air injectors are provided adjacent the filters including a first injector and at least one neighboring injector. Self-cleaning is achieved while the blower fan is running by performing several steps including activating the first injector to force compressed air into the first filter and discharge particulate from the first filter followed by deactivating the first injector. The steps further provide reactivating the first injector and simultaneously activating the neighboring injector while the discharged particulate is airborne to provide an air shield about the first filter and force the discharged particulate away from the first filter and the neighboring filter. These steps are repeated for each filter.

5 Claims, 3 Drawing Sheets



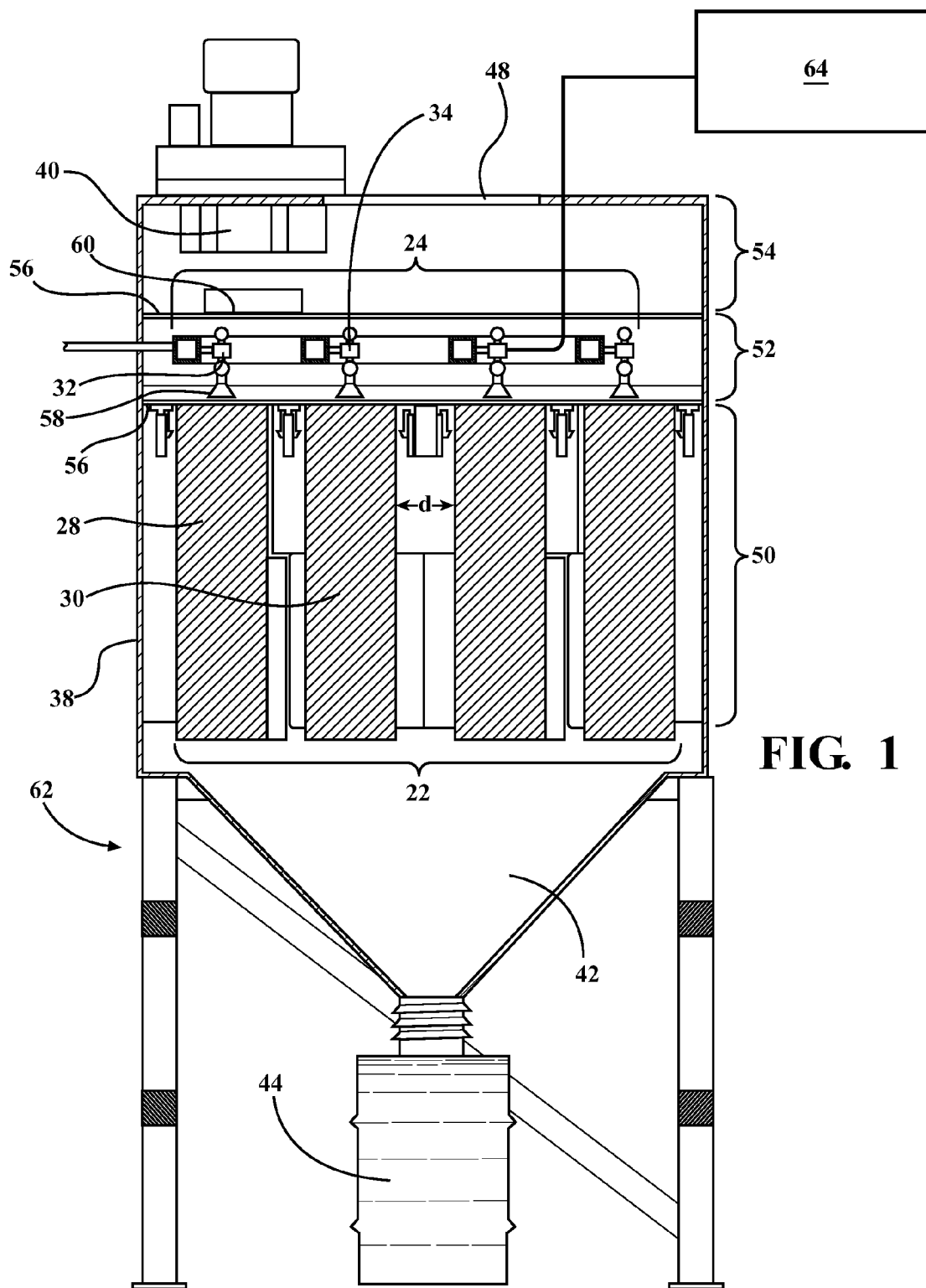
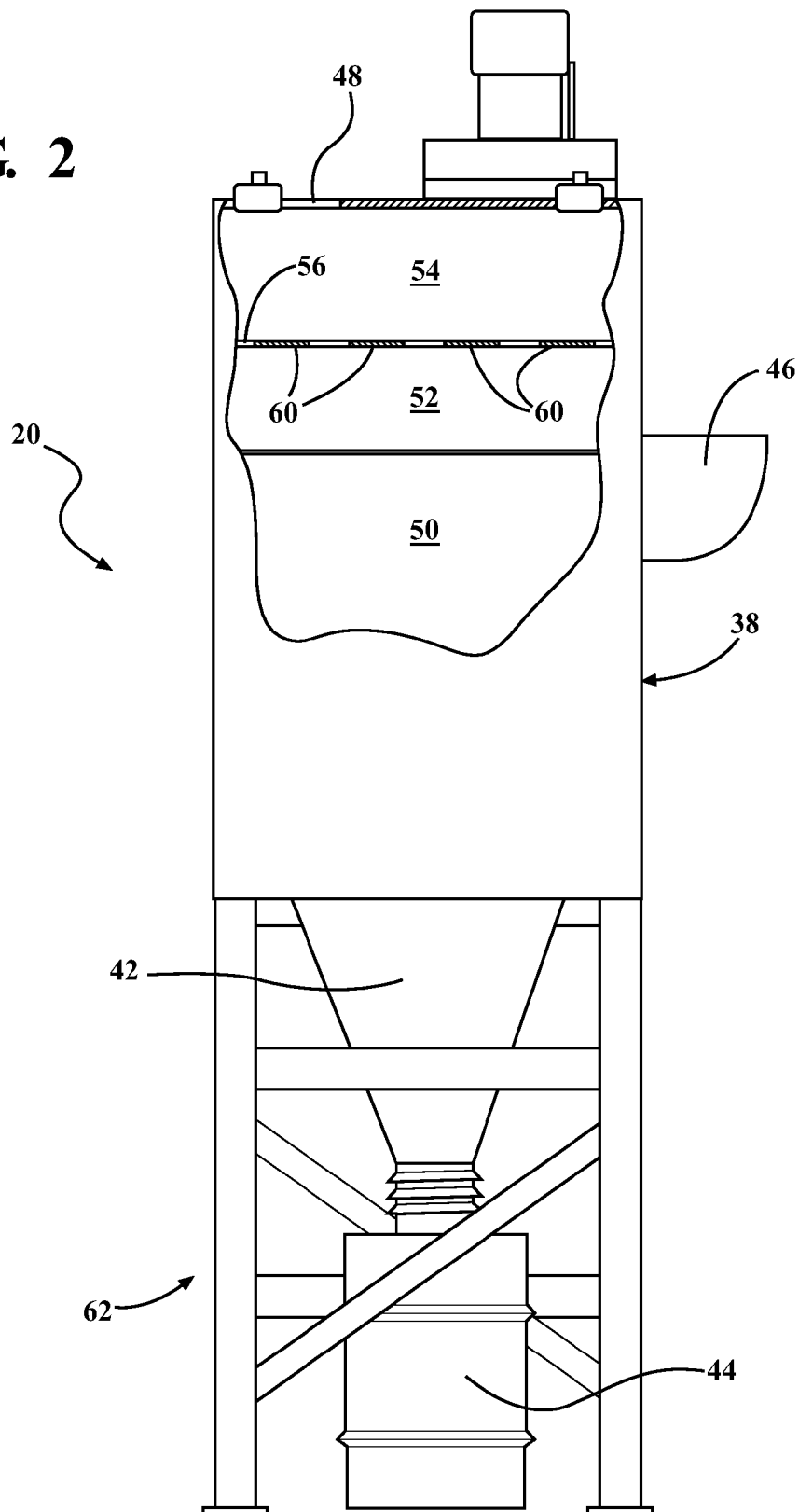


FIG. 2



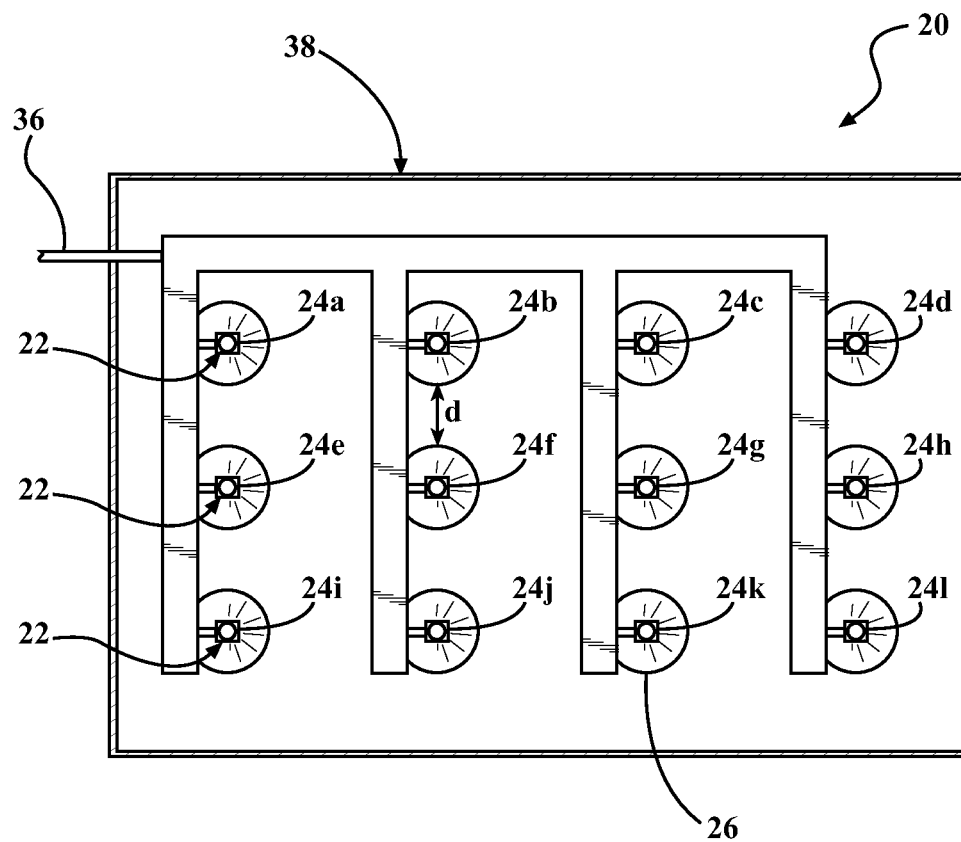


FIG. 3

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CONTROLLED PULSE AIR FILTER SYSTEM**CROSS REFERENCE TO RELATED APPLICATION**

This application claims priority to and the benefit of U.S. Provisional Patent Application Ser. No. 61/702,378, filed Sep. 18, 2012, the entirety of which is hereby incorporated by reference.

TECHNICAL FIELD

This invention relates generally to air filtering systems and, more particularly, to a controlled pulse air filtering system. A method for self-cleaning the filters of such an air filtering system is also described and claimed herein.

BACKGROUND OF THE INVENTION

Air filtering units are commonly used in manufacturing processes. One typical application is to clean the air within a welding station. A conduit is connected between an opening in the welding station and the air filtering unit. During operation of the air filtering unit, the air within the welding station is drawn from the welding station, through the conduit and into the filtering unit by a blower fan. A plurality of filters are mounted in the filtering unit and the air from the welding station is pulled through the filters. The filters extract the particulate from the air and then the air is expelled from the filter unit back into the surrounding environment.

Over time, the filters become dirty with the particulate and require cleaning. There are typically two times when the filters are cleaned. One time is during total shut down and the other during operation. The latter is done to extend the period between the cleanings done at total shutdown. Shutdown, as will be appreciated, effects the normal operation of the manufacturing operations and the longer the period between the total shutdowns for cleaning the better.

To clean such air filtering units, air injectors are traditionally positioned adjacent to each of the filters. The air injectors are supplied with compressed air. All of the air injectors are simultaneously actuated forcing compressed air into and through the filters, from the inside to the outside, for the purpose of discharging any particulates that have accumulated on the filters. Generally, the compressed air released from the air injectors and gravity directs the discharged particulates into a collector unit disposed below the filters. During total shutdown, a large amount of the particulate that has accumulated on the filters can be forced out of the filters. However, during cleaning with the unit operational (i.e. when the blower fan is running), only a small amount of the particulate is discharged and most is sucked back onto the filters because the filter unit is drawing air through the filters. The particulate that is discharged from the filters is for the most part immediately pulled back onto the filters.

The controlled pulse of the present invention overcomes this problem of the discharged particulate being drawn back onto the filters during cleaning operations when the filter unit is operational.

SUMMARY OF THE INVENTION

In general terms, this invention provides an improved method for cleaning the filters of an air filtering unit while the unit is operational. The method of the present invention includes providing a plurality of air filters and providing a plurality of compressed air injectors adjacent the air filters.

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During operation of the unit, a first injector is activated to force compressed air into a first filter. This discharges particulate from the first filter. After activating the first injector, the first injector is immediately deactivated and re-activated. When the first injector is re-activated, the injectors directly adjacent the first injector are also activated. This step is performed while the discharged particulate is airborne to shield the first filter and force at least a portion of the discharged particulate away from the first filter and the adjacent filters. After the first filter is cleaned in accordance with this method, the operation is performed on each of the remaining filters.

According to another aspect of the invention, a self-cleaning air filtering system is provided. The self-cleaning air filtering system includes a programmable logic controller operably connected to compressed air injectors to actuate the injectors. The programmable logic controller is programmed with executable instructions defined by the steps of the inventive method described above. Accordingly, the executable instructions of the programmable logic controller include activating a first injector to force compressed air into the first filter and discharge particulate from the first filter. The first injector is deactivated for a short time and then the first injector is reactivated along with injectors directly adjacent the first injector. This is done while the discharged particulate is airborne to provide an air shield about the first filter and force at least a portion of the discharged particulate away from the first filter. The programmable logic controller is programmed to repeat the executable instructions for each of the air filters in the system.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a front cutaway view of the controlled pulse air filter system of the present invention;

FIG. 2 is a side partial cutaway view of the controlled pulse air filter system of the present invention; and

FIG. 3 is a top cutaway view of the controlled pulse air filtering system showing the plurality of compressed air injectors of the present invention.

DESCRIPTION OF THE ENABLING EMBODIMENT

Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, a method for cleaning particulate from the filters of an air filtering system is provided.

Referring to FIGS. 1 and 2, the method is performed by initially providing an air filtering system 20. The disclosed air filtering system 20 includes a plurality of air filters 22 serviced by a plurality of compressed air injectors 24. While the plurality of air filters 22 may be arranged in a variety of configuration in accordance with the invention, it is envisioned that the filters 22 may be disposed in side-by-side spaced relationship. Similarly, each filter 22 in the plurality of air filters 22 may take a variety of shapes and configurations without departing from the scope of this invention. For example, each air filter 22 may include a filter material 26 of an elongated cylindrical shape surrounding a hollow core. The filters 22 may be spaced apart from one another by a predetermined distance d extending linearly between the

filter material 26 of adjacent filters 22. As such, the predetermined distance d may be the smallest distance that can be measured between adjacent filters 22 arranged in side-by-side spaced relationship.

Still referring to FIGS. 1 and 2, the plurality of air filters 22 include a first filter 28 and at least one neighboring filter 30 adjacent the first filter 28. Similarly, the plurality of compressed air injectors 24 include a first injector 32 and at least one neighboring injector 34 adjacent the first injector 32. It should be appreciated that the first injector 32 is disposed adjacent the first filter 28 and that each neighboring injector 34 is disposed adjacent the corresponding neighboring filter 30. In accordance with this aspect of the invention, there is at least one compressed air injector 24 for each filter 22. A compressed air supply 36 is provided in fluid communication with the compressed air injectors 24 to supply the injectors 24 with a source of compressed air. It should be appreciated that the present invention is not limited to a compressed air supply 36 and that other types of compressed gas may alternatively be supplied to the injectors 24. It should also be appreciated that where the filters 22 have a cylindrically shaped filter material 26 defining a hollow core, each of the compressed air injectors 24 may be aimed such as to provide a pulse of compressed air into the hollow core of the filters 22. Without intending to be bound by the theory, it is believed that the pulse of compressed air into the hollow core of the filters 22 discharges particulate that has accumulated on the filter material 26 by introducing a shockwave of air into the filter 22. It is further believed that this shockwave functions to expand folded pleats of the filter material 26 thereby releasing dirt that has accumulated on the filter 22.

The plurality of air filters 22 may be provided within a housing 38. A blower fan 40 may be provided in fluid communication with the housing 38 to facilitate the flow of air through the filters 22. While the housing 38 may take a variety of forms, the housing 38 may be generally rectangular in shape. The housing 38 may also be provided with a collector unit 42 in fluid communication with the filters 22. During use of the air filtering system 20, the collector unit 42 may collect and trap particulate disposed within the housing 38. Generally, the collector unit 42 may take the form of a frustoconical shape extending downwardly from the housing. The collector unit 42, or a trap 44 attached thereto, may be removably attached to the housing 38 for ease of cleaning. Together with the collector unit 42, the housing 38 may define an inlet 46 for receiving a volume of air to be filtered. The housing 38 may further define an outlet 48 for discharging a volume of filtered air after it has passed through the filters 22.

The method includes a series of steps wherein the compressed air injectors 24 are actuated to deliver a series of controlled pulses of compressed air to the plurality of air filters 22. The method includes the step of activating the first injector 32 for a first time duration to force compressed air into the first filter 28 and discharge particulate from the first filter 28. This step is referred to herein as the activating step. It should be appreciated that during the activating step, the first injector 32 is activated while the at least one neighboring injector 34 remains deactivated. The method proceeds with the step of deactivating the first injector 32 for a second time duration. This step is referred to herein as the deactivating step. The second time duration of the deactivating step may be shorter than the first time duration of the activating step. Accordingly, the first injector 32 may be deactivated for only a brief moment. More specifically, the second time duration of the deactivating step is less than a

time required for the discharged particulate to travel the predetermined distance d between the first filter 28 and the neighboring filter 30 or neighboring filters 30. This allows enough time for the particulate to leave the first filter 28 but does not present enough time for the particulate to migrate across the predetermined distance d to become entrained on the at least one neighboring filter 30.

The method further includes the step of reactivating the first injector 32 and simultaneously activating the at least one neighboring injector 34 for a third time duration. This step is referred to herein as the reactivating step. As the term is used herein, the reactivating step includes both the reactivation of the first injector 32 and the simultaneous activation of the at least one neighboring injector 34. The third time duration of the reactivating step may be longer than the first time duration of the activating step. Accordingly, the first injector 32 and the at least one neighboring injector 34 provide simultaneous pulses of compressed air while the discharged particulate is airborne and force at least a portion of the discharged particulate away from the first filter 28 and the at least one neighboring filter 30, directing the discharged particulate towards the collector unit 42. Without intending to be bound by the theory, it is believed that the reactivating step provides an air shield about the first filter 28 that prevents the first filter 28 and the at least one neighboring filter 30 from entrapping or re-entrapping the discharged particulate when it is airborne as a result of the activation of the first injector 32 during the activation step.

In addition to differences in the time duration between compressed air pulses of the activating and reactivating steps, the pressure of the compressed air may differ between the activating and reactivating step. For instance, the activating step of activating the first injector 32 to force compressed air into the first filter 28 and discharge particulate from the first filter 28 may further include supplying a first pressure pulse to the first filter 28. The reactivating step of reactivating the first injector 32 and activating the at least one neighboring injector 34 simultaneously following the deactivation of the first injector 32 and while the discharged particulate is airborne may further include supplying a second pressure pulse simultaneously to the first filter 28 and the at least one neighboring filter 30 wherein the first pressure pulse is greater than the second pressure pulse. In other words, the first pressure pulse of the activating step may be of a higher or greater positive pressure than that of the second pressure pulse of the reactivating step.

These method steps may then be repeated for each of the plurality of air filters 22. Consequently, the filter 22 being designated as the first filter 28 will change with each iteration of the method until all of the filters 22 have been cleaned by the controlled pulses of compressed air. Advantageously, the subject method may be employed during operation of the air filtering system 20. As such, the method of delivering the controlled pulses of compressed air to the filters 22 may be performed while air is being communicated through the filters 22. In other words, the method steps recited above may all be performed while the blower fan 40 is running to draw air through the filters 22. Nevertheless, it should be appreciated that the subject method may be performed while the air filtering system 20 is not in operation.

More particularly, FIG. 3 illustrates an exemplary air filter system 20 of the subject invention having a total of twelve filters 22 and twelve injectors 24a-1. For a first exemplary iteration of the method described herein, injector 24a may be designated as the first injector 32 and injectors 24b, 24f, and 24e may be designated as the neighboring injectors 34

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observing that injectors **24b**, **24f**, and **24e** are directly adjacent injector **24a**. In accordance with the method described herein, the first injector **24a** is activated while the neighboring injectors **24b**, **24f**, and **24e** remain deactivated. Next, the first injector **24a** is deactivated. Following the deactivation of the first injector **24a**, the first injector **24a** is reactivated and, at the same time, the neighboring injectors **24b**, **24f**, and **24e** are activated to shield the filters **22** from the discharged particulate as it travels to the collector unit **42**. This cleaning methodology may then be repeated for each of the filters **22** and repeats itself for as long as the air filter system **20** is in operation.

For instance, the method may continue with a second exemplary iteration wherein injector **24b** is designated as the first injector **32** and injectors **24a**, **24f**, and **24c** are designated as the neighboring injectors **34** observing that injectors **24a**, **24f**, and **24c** are directly adjacent injector **24b**. In accordance with the method, the first injector **24b** is activated while the neighboring injectors **24a**, **24f**, and **24c** remain deactivated. Next, the first injector **24b** is deactivated. Following the deactivation of the first injector **24b**, the first injector **24b** is reactivated and, at the same time, the neighboring injectors **24a**, **24f**, and **24c** are activated. It should be appreciated that in the second exemplary iteration, the plurality of neighboring injectors **34** could be expanded to further include injectors **24e** and **24g**.

Similarly, the method may continue with a third exemplary iteration wherein injector **24f** is designated as the first injector **32** and injectors **24b**, **24e**, **24j**, and **24g** are designated as the neighboring injectors **34** observing that injectors **24b**, **24e**, **24j**, and **24g** are directly adjacent injector **24f**. In accordance with the method, the first injector **24f** is activated while the neighboring injectors **24b**, **24e**, **24j**, and **24g** remain deactivated. Next, the first injector **24f** is deactivated. Following the deactivation of the first injector **24f**, the first injector **24f** is reactivated and, at the same time, the neighboring injectors **24b**, **24e**, **24j**, and **24g** are activated. Again, it should be appreciated that in the third exemplary iteration, the plurality of neighboring injectors **34** could be expanded to further include injectors **24a**, **24i**, **24k** and **24c**.

Referring back to FIGS. **1** and **2**, a self-cleaning air filtering system **20** adapted to perform the method described herein is provided. The air filtering system **20** has a housing **38** including an inlet **46** and an outlet **48**. The housing **38** may be divided into several plenums including a first plenum **50**, a second plenum **52**, and a third plenum **54** each being partially separated from one another by a plurality of dividers **56**. The first plenum **50**, also referred to as the dirty air plenum, is adjacent the inlet **46** and receives a volume of air from the inlet **46** to be filtered. As an example, the inlet **46** may be in fluid communication with a welding station. The first plenum **50** houses a plurality of air filters **22** including a first filter **28** and at least one neighboring filter **30** adjacent the first filter **30**. The plurality of air filters **22** may be disposed in side-by-side spaced relationship and each air filter **22** includes a filter material **26** of an elongated cylindrical shape surrounding a hollow core. The plurality of air filters **22** may be mounted to the divider **56** partially separating the first plenum **50** and the second plenum **52**. Additionally, this divider **56** may include a plurality of holes that are radially aligned with the hollow core of each filter **22** through which air may travel from the first plenum **50** to the second plenum **52**.

The second plenum **52**, also referred to as the air tank plenum, is disposed between the first plenum **50** and the third plenum **54**. The second plenum **52** may house a plurality of compressed air injectors **24** adjacent to the air

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filters **22** including a first air injector **32** adjacent the first filter **28** and at least one neighboring injector **34** adjacent each neighboring filter **30**. The air injectors **24** are positioned to force compressed air into the hollow core of the air filters **22** and each injector **24** may further include a nozzle **58** configured to diffuse the air pulse provided by the injector **24** over a larger area. A compressed air supply **36** is provided in fluid communication with the compressed air injectors **24** to supply the injectors **24** with compressed air. It should be appreciated that the compressed air supply **36** could be a tank of compressed air or an air compressor. Further, the compressed air supply **36** may be part of the air filtering system **20**, a standalone unit, or a compressed air line common in many factories or plants. As such, the capacity of the compressed air supply **36** may be limited such that the pressure provided to the injectors **24** may vary depending on the frequency with which the injectors **24** are activated. The divider **56** partially separating the second plenum **52** and the third plenum **54** may include a plurality of venturi openings **60** through which air may travel from the second plenum **52** to the third plenum **54**.

The third plenum **54**, also referred to as the blower plenum, is adjacent the outlet **48** which discharges the filtered air. The third plenum **54** may house a blower fan **40** for drawing air through the air filtering system **20**. As a result of the blower fan **40** in combination with the venturi openings **60**, the first plenum **50** and second plenum **52** may operate in a negative pressure environment while the third plenum **54** may operate in a positive pressure environment. The negative pressure environment of the first plenum **50** and second plenum **52** facilitates drawing dirty air in through inlet **46** and through the filters **22** from outside the filter material **26** to inside the hollow core. The positive pressure environment of the third plenum **54** facilitates expelling filtered air out through the outlet **48**. Accordingly, an exemplary flow path of air through the air filtering system **20** is as follows. Air is drawn in through the inlet **46** and received in the first plenum **50**. The air is pulled through the filters **22** from outside the filter material **26** and into the hollow core of the filters **22**. The air passes from the hollow core of the filters **22**, through the holes in the divider **56** separating the first plenum **50** and the second plenum **52**, and into the second plenum **52**. The air then travel from the second plenum **52** to the third plenum **54** through the venturi openings **60**. Once in the third plenum **54**, the air is expelled through the outlet **48**.

A collector unit **42** is disposed in fluid communication with the filters **22** for collecting and trapping particulate. More particularly, the collector unit **42** may be connected to the housing **38** adjacent the first plenum **50**. Both the air pulses from the injectors **24** and gravity may facilitate the passage of particulate from the filters **22** to the collector unit **42**. The collector unit **42** may have upwardly sloping sides or may have a frustoconical shape. A trap **44** may be removably connected to the collector unit **42** for receiving the particulate. The trap **44** may generally be barrel shaped and disposed beneath the collector unit **42**. As such, the trap **44** can be disconnected and cleaned. Alternatively, the trap **44** may be in the form of a tray that may be slid out from the collector unit **42** and cleaned. The air filtering system **20** may be supported by a frame **62**. The frame **62** may be attached to the collector unit **42** and/or the housing **38**.

The air filtering system **20** further includes a programmable logic controller **64** electrically connected to the compressed air injectors **24**. The programmable logic controller **64** is programmed with executable instructions including activating the first air injector **32** for a first time

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duration to force compressed air into the first filter **28**. This discharges particulate from the first filter **28**, rendering it airborne outside the filter material **26** of the first filter **28** and within the first plenum **50**. The executable instructions also include deactivating the first air injector **32** for a second time duration being shorter than the first time duration and reactivating the first air injector **32** and simultaneously activating the at least one neighboring injector **34** for a third time duration being longer than the first time duration. Accordingly, the first injector **32** is reactivated and the at least one neighboring injector **34** is simultaneously activated while the discharged particulate is airborne to provide an air shield about the first filter **28** and force at least a portion of the discharged particulate away from the first filter **28** and the at least one neighboring filter **30** and towards the collector unit **42**. The programmable logic controller **64** further provides for repeating the executable instructions for each of the air filters **22**.

As a result of these executable instructions and the method described above, a greater amount of the discharged particulate is forced into the collector unit **42** than would be achieved by traditional online cleaning operations where all of the injectors **24** are activated at the same time while the blower fan **40** is running. Through testing, as much as five times the discharged particulate reached the collector unit **42** when compared to the traditional online cleaning operation.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings and may be practiced otherwise than as specifically described while within the scope of the appended claims. These antecedent recitations should be interpreted to cover any combination in which the inventive novelty exercises its utility. The use of the word "said" in the apparatus claims refers to an antecedent that is a positive recitation meant to be included in the coverage of the claims whereas the word "the" precedes a word not meant to be included in the coverage of the claims. In addition, the reference numerals in the claims are merely for convenience and are not to be read in any way as limiting.

What is claimed is:

1. A method for operating a filter system, the method comprising:
 - providing a filter system, wherein the filter system comprises:
 - a plurality of filters including a first filter and a second filter, the first and second filters being spaced from one another;
 - a collector unit provided below the plurality of filters;
 - a first injector disposed adjacent to the first filter and a second injector disposed adjacent to the second filter;
 - the method further comprising:
 - a filtering step wherein the plurality of filters extract particulates from contaminated air as the contaminated air moves through the plurality of filters in a filtering direction, and
 - a cleaning step wherein at least the first and second filters are cleaned, the cleaning step comprises:
 - a first time duration wherein the first injector is activated to supply a first pressurized air pulse to the first filter in a direction opposite than the filtering direction to discharge a plurality of particulates from the first filter, the second injector is deactivated during the first time duration such that pressurized air does not enter the second filter through the second injector,
 - a second time duration after the first time duration wherein the first injector is deactivated such that dis-

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charged particulates from the first filter are suspended while airborne in the space between the first and second filters, and

- a third time duration after the second time duration wherein the first and second injectors are simultaneously activated to supply pressurized air pulses to the first and second filters in a direction opposite to the filtering direction while the particulates are suspended and airborne in the space between the first and second filters, such that the pressurized air pulses force at least a portion of the discharged particulate away from the first and second filters thereby directing the discharged particulate towards the collector unit.
2. A method as set forth in claim **1** wherein the cleaning step is repeated such that each filter in the plurality of filters is sequentially designated as the first filter at each repetition of the cleaning step.
3. A method as set forth in claim **1** wherein the second time duration is shorter than the first time duration.
4. A method as set forth in claim **1** wherein the third time duration is longer than the first time duration.
5. A method for operating a filter system, the method comprising:
 - providing a filter system, wherein the filter system comprises:
 - a plurality of filters including a first filter and a second filter, the first and second filters being spaced from one another;
 - a collector unit provided below the plurality of filters;
 - a first injector disposed adjacent to the first filter and a second injector disposed adjacent to the second filter;
 - the method further comprising:
 - a filtering step wherein the plurality of filters extract particulates from contaminated air as the contaminated air moves through the plurality of filters in a filtering direction, and
 - a cleaning step wherein at least the first and second filters are cleaned, the cleaning step comprises:
 - a first time duration wherein the first injector is activated to supply a first pressurized air pulse to the first filter in a direction opposite than the filtering direction to discharge a plurality of particulates from the first filter, the second injector is deactivated during the first time duration such that pressurized air does not enter the second filter through the second injector,
 - a second time duration after the first time duration wherein the first injector is deactivated such that discharged particulates from the first filter are suspended while airborne in the space between the first and second filters, and
 - a third time duration after the second duration wherein the first and second injectors are simultaneously activated to supply pressurized air pulses to the first and second filters in a direction opposite to the filtering direction while the particulates are suspended and airborne in the space between the first and second filters, such that the pressurized air forces at least a portion of the discharged particulate away from the first and second filters thereby directing the discharged particulate towards the collector unit, wherein
 - the second time duration is shorter than the first time duration, wherein
 - the third time duration is longer than the first time duration, and wherein

the cleaning step is repeated such that each filter in the plurality of filters is sequentially designated as the first filter at each repetition of the cleaning step.

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